Western Resources®

February 24, 2000

Mr. William Grimley
Emission Measurement Center (MD-19)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711

RE: Electric Utility Steam Generating Unit Mercury Test Program

Per the U.S. Environmental Protection Agency (USEPA) letter, dated March 11, 1999, speciated mercury emission testing was conducted at Western Resources' Lawrence Energy Center Unit 4. Enclosed are two (2) bound copies and one (1) unbound copy of the final report.

Please contact Richard Finger at (785) 575-6517/ dick_finger@wr.com(phone/e-mail), if there are questions regarding the enclosed report.

Sincerely,

Richard Finger
Lead Engineer

Enclosures (3)

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SOURCE EMISSIONS SURVEY
OF
WESTERN RESOURCES, INC.
LAWRENCE ENERGY CENTER
UNIT NUMBER 4 SOUTH SCRUBBER INLET DUCT
AND SOUTH STACK
LAWRENCE, KANSAS
FOR
ELECTRIC POWER RESEARCH INSTITUTE

OCTOBER 1999

FILE NUMBER 99-95LAW4

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1 INTRODUCTION

1.1 Summary of Test Program

METCO Environmental, Dallas, Texas, conducted a source emissions survey of Western Resources, Inc., Lawrence Energy Center, located in Lawrence, Kansas, for the Electric Power Research Institute, on October 25 and 26, 1999. The purpose of these tests was to meet the requirements of the EPA Mercury Information Request. Speciated mercury concentrations at the Unit Number 4 South Scrubber Inlet Duct, speciated mercury emissions at the Unit Number 4 South Stack, and mercury and chlorine content of the fuel were determined. The sulfur, ash, and Btu content of the fuel were also determined.

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999; and ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286.

1.2 Key personnel

Mr. Bill Hefley of METCO Environmental was the onsite project manager. Mr. Shane Lee, Mr. Mike Bass, Mr. Jason Conway, Mr. Scott Hart, and Mr. Jason Brown of METCO Environmental performed the testing.

Mr. Richard Finger of Western Resources, Inc. acted as the utility representative and performed process monitoring and sampling.

Mr. Paul Chu was the Electric Power Research Institute project manager.

Table 1-1
Test Program Organization

Organization	Individual	Responsibility	Phone Number
Project Team			
METCO	Bill Hefley	Project Manager	(972) 931-7127
Utility			
Western Resources, Inc.	Richard Finger	Utility Representative & Process Monitoring	(785) 575-6517
QA/QC			
EPRI	Paul Chu	Project Manager	(650) 855-2812

2 SOURCE AND SAMPLING LOCATION DESCRIPTIONS

2.1 Process Description

The Lawrence Energy Center (LEC) Unit Number 4 boiler is a Combustion Engineering controlled circulation, tilting burner, tangential-fired boiler of approximately 115 megawatt net capacity capable of firing gaseous, liquid, and/or solid fossil fuel with solid fossil fuel being the primary fuel. Flue gas leaving the economizer section of the boiler flows through two rotary air heaters and then flows through two ducts to the inlets of two (2) CE wet limestone, venturi-absorber scrubber modules and is exhausted through two steel stacks.

Four coal silos, located above the pulverizers, store crushed coal which is supplied, as needed, to the pulverizers by variable speed feeders. Pulverized solid fossil fuel is supplied to the boiler from our (4) "bowl mill" type pulverizers. Hot air, drawn through the mill by the exhauster (fan), dries the coal as it is pulverized and transports it from the grinding chamber, through the classifiers, to the burners. As noted above, the combustion gas passes through two separate ducts, which route flue gas to the inlet of the particulate scrubber. The flue gas flows through the particulate scrubber to the adsorber section, mist eliminators, the flue gas reheater, the ID fan and finally to the stack.

2.2 Control Equipment Description

2.2.1 *Particulate Scrubber*

The particulate scrubber consists of a converging section which leads the down flowing gas to a compartment which is comprised of two (2) staggered layers of rod assemblies. The vertical spacing between the two sets of rods is varied automatically in proportion to the gas flow in order to maintain a set pressure drop across the rods. The control mechanism for adjusting the rod spacing includes four (4) screw jacks driven by a DC drive motor.

The particulate scrubber removes particulate by maintaining a set pressure drop across the rods, in conjunction with a continuous spraying of slurry on the rods. In addition to removing the particulate from the flue gas, the particulate scrubber removes a portion of the total SO_2 from the flue gas stream. The active alkalinity (from limestone and flyash) in the rod section spray absorbs some SO_2. The scrubbing slurry to the particulate scrubber is introduced by means of a series of ceramic nozzles. Some of the nozzles are directed at the converging walls above the rods to maintain them in a clean state, while others provide slurry spray for the rods. The spent spray slurry drops into the reaction tank after contact with the flue gas.

2.2.2 *Absorber*

After leaving the particulate scrubber, the flue gas makes a 180° turn and flows upward through the SO_2 absorber. The function of the spray tower absorber is to transfer SO_2 from the gas to the slurry. In the absorber, the slurry is distributed uniformly via a series of ceramic spray nozzles mounted in a spray bank. The pressurized spray nozzles produce finely dispersed droplets of slurry that provide adequate surface area for transfer of SO_2 into the liquid slurry.

Retention (contact) time in the absorber is provided by the tower's effective height and the flue gas velocity. The slurry drains through the bottom of the spray tower into the reaction tank.

2.2.3 Mist Eliminator

The gas leaving the absorber spray tower passes through a mist eliminator section, which is composed of a bulk entrainment separator and two (2) levels of mist eliminator vanes. The bulk entrainment separator consists of fiberglass reinforced polyester vanes mounted at a 45° angle to the gas flow on 3 inch spacings, extending across the entire area of the absorber tower. Its function is to separate the bulk (larger) water droplets from the gas.

The two (2) levels of "V" shaped mist eliminator vanes are also made up of fiberglass reinforced polyester material. These are arranged in a series of chevrons, extending across the entire area of the tower. The mist eliminators function is to separate smaller droplets of entrained moisture from the gas that have passed the bulk entrainment separator.

Periodically, the lower mist eliminator vanes and the bulk entrainment separator must be washed to remove particulate buildups. Water washers utilizing scrubber makeup pond return water are used in the washing process. Each washer is located between the bulk entrainment separator and the lower mist eliminator vanes. The washer lances rotate 360° while traversing. The scrubber module must be out of service during a mist eliminator wash.

2.2.4 *Reheater*

From the mist eliminator the gases enter the reheater. The reheater dries the gases and then heats them up to 145 °F to improve the flue gas buoyancy and to reduce the stack plume. Baffles around the perimeter of the duct prevent the flue gases from bypassing the reheater by directing the flow across the reheater elements.

2.3 Flue Gas and Process Sampling Locations

2.3.1 *Inlet Sampling Location*

The sampling location on the Unit Number 4 South Scrubber Inlet Duct is 49 feet above the ground. The sampling locations are located 29 feet 6 inches (3.69 equivalent duct diameters) downstream from a bend in the duct and 8 feet (1.00 equivalent duct diameters) upstream from a bend in the duct.

2.3.2 *Stack Sampling Location*

The sampling location on the Unit Number 4 South Stack is 126 feet above the ground. The sampling locations are located 82 feet (10.78 stack diameters) downstream from the inlet to the stack and 46 feet 4 inches (6.09 stack diameters) upstream from the outlet of the stack.

2.3.3 *Coal Sampling Location*

The coal sampling locations are located at the outlet of each individual mill.

Figure 2-1
Description of sampling locations at Lawrence Unit Number 4 South Scrubber Inlet Duct

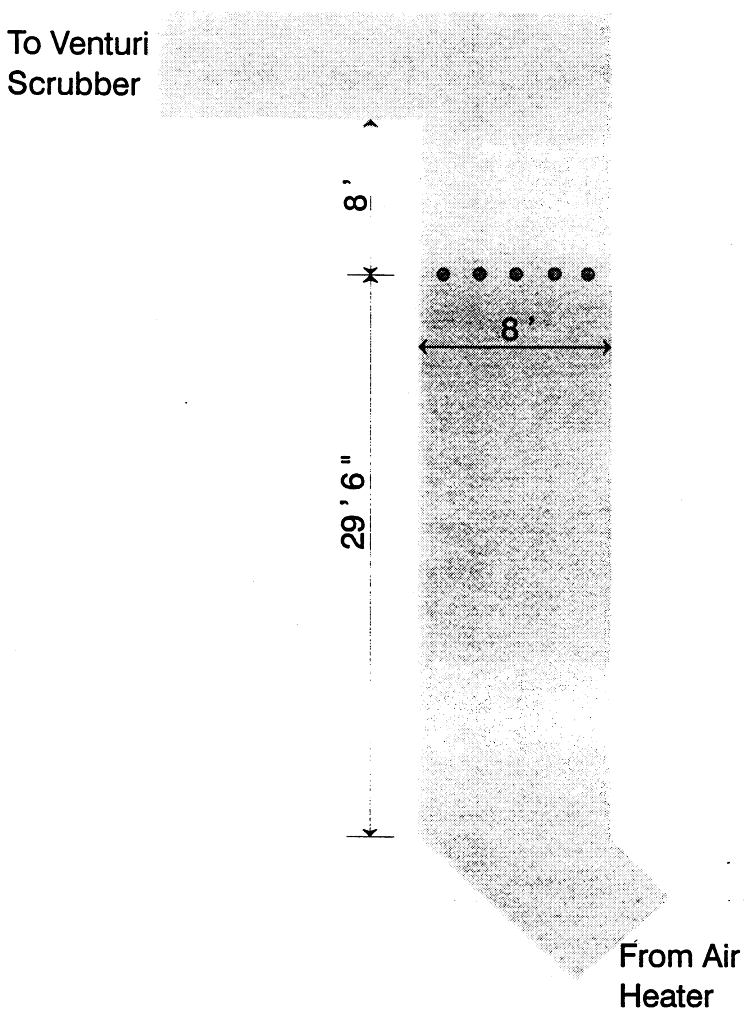


Figure 2-2
Description of sampling points at Lawrence Unit Number 4 South Scrubber Inlet Duct

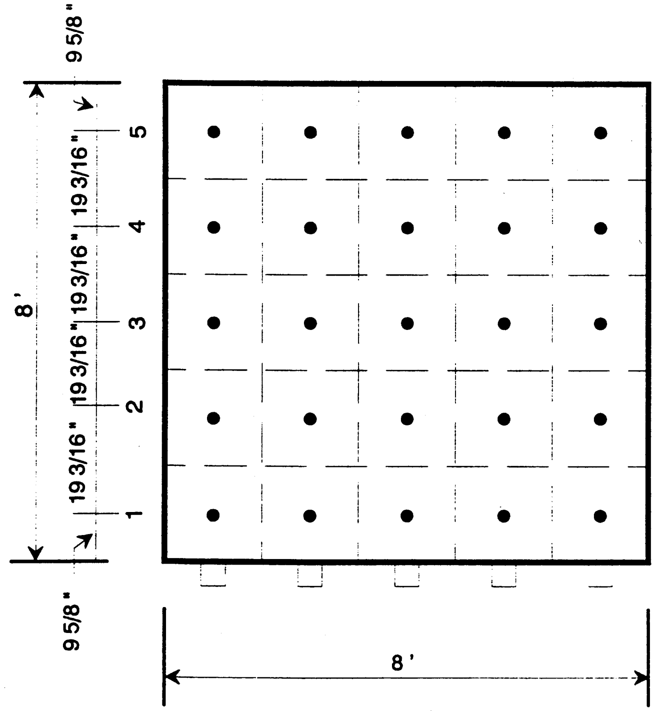


Figure 2-3
Description of sampling locations at Lawrence Unit Number 4 South Stack

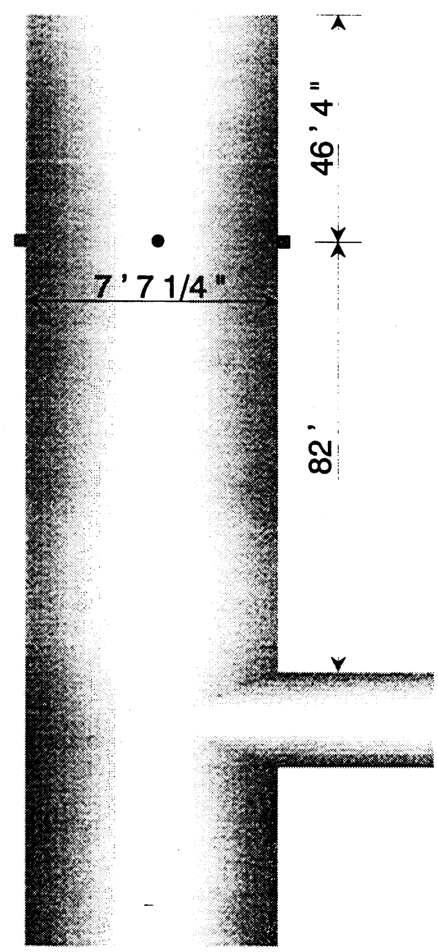
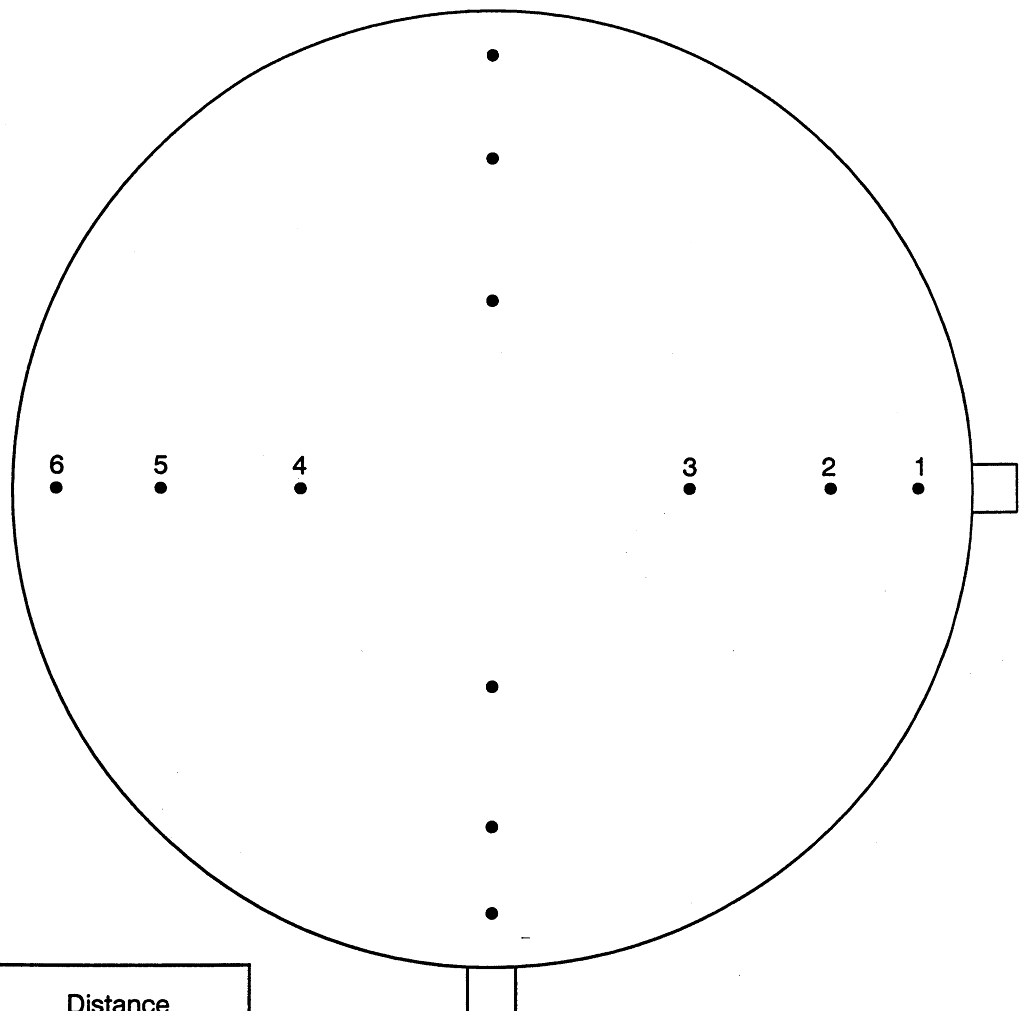
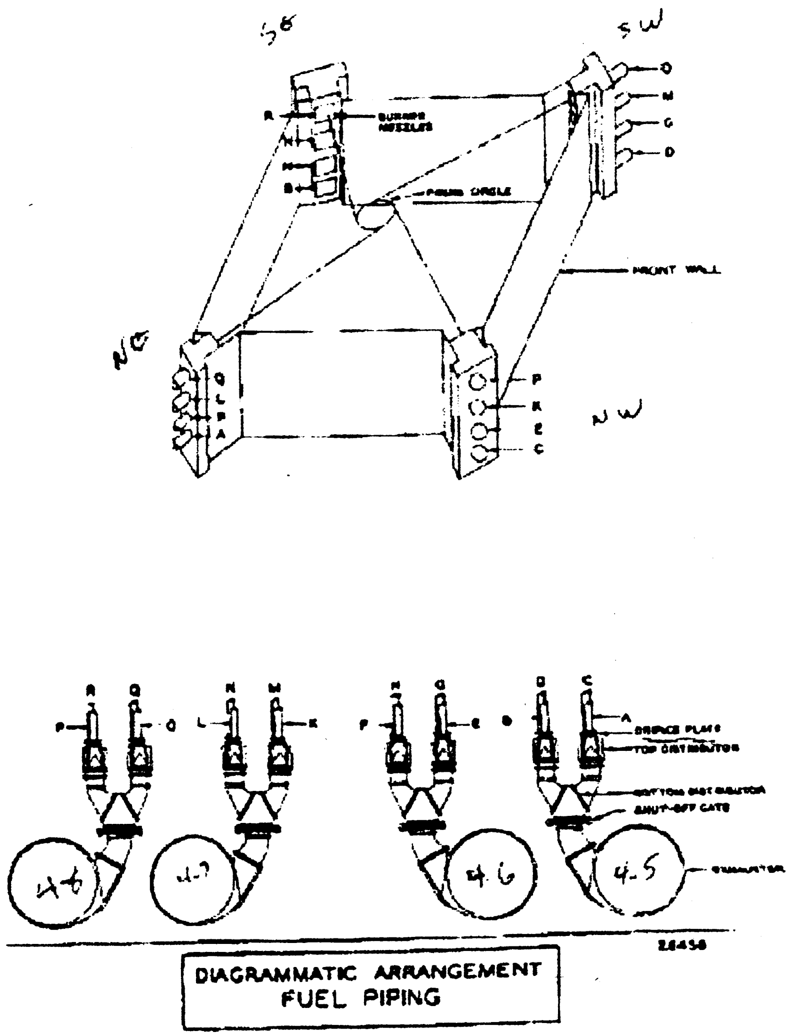


Figure 2-4
Description of sampling points at Lawrence Unit Number 4 South Stack



Point	Distance from Wall
1	4 "
2	13 5/16 "
3	27 "
4	64 1/4 "
5	77 15/16 "
6	87 1/4 "

Figure 2-5
Description of coal sampling locations at Lawrence Unit Number 4



3 SUMMARY AND DISCUSSION OF RESULTS

3.1 Objectives and Test Matrix

3.1.1 Objective

The objective of the tests was to collect the information and measurements required by the EPA Mercury ICR. Specific objectives listed in order of priority are:

1. Quantify speciated mercury emissions at the stack.
2. Quantify speciated mercury concentrations in the flue gas at the scrubber inlet.
3. Quantify fuel mercury and chlorine content during the stack and inlet tests.
4. Provide the above information for use in developing boiler, fuel, and specific control device mercury emission factors.

3.1.2 Test Matrix

The test matrix is presented in Table 3-1. The table includes a list of test methods was used. In addition to speciated mercury, the flue gas measurements include moisture, flue gas flow rates, carbon dioxide, and oxygen.

Table 3-1
Test Matrix for Mercury ICR Tests at Lawrence Unit Number 4

Sampling Location	No. of Runs	Species Measured	Sampling Method	Sample Run Time	Analytical Method	Analytical Laboratory
South Stack	3	Speciated Hg	Ontario Hydro	120 min	Ontario Hydro	TestAmerica
South Stack	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
South Stack	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
South Stack	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
South Inlet	3	Speciated Hg	Ontario Hydro	125 min	Ontario Hydro	Test America
South Inlet	3	Moisture	EPA 4	Concurrent	Gravimetric	METCO
South Inlet	3	Flue Gas Flow	EPA 1 & 2	Concurrent	Pitot Traverse	METCO
South Inlet	3	O_2 & CO_2	EPA 3B	Concurrent	Orsat	METCO
Mill	3	Hg, Cl, Sulfur, Ash, and Btu/lb in coal	ASTM D2234	1 grab sample every 30-minutes per mill per run	ASTM D6414-99 (Hg), ASTM E776/300.0 (Cl), ASTM D-4239 (S), ASTM D-3174 (Ash), and ASTM D-3286 (Btu/lb)	TestAmerica and Philip Services

3.2 Field Test Changes and Problems

No deviations were made from the approved Sampling and Analytical Test Plan. Run Number 3 was aborted due to sampling equipment problems. An additional test (Run Number 4) was performed.

3.3 Handling of Non-Detects

This section addresses how data will be handled in cases where no mercury is detected in an analytical fraction. It should be noted that the analytical method specified in the Ontario Hydro Method has a very low detection limit, which is expected to be well below flue gas levels for most cases if the laboratory uses normal care and state of the art analytical equipment. However, there may be cases where certain fractions of a test do not show detectable mercury levels. This section addresses how non-detects will be handled in calculating and reporting mercury levels.

3.3.1 A single analytical fraction representing a subset of a mercury species is not detected.

When more than one sample component is analyzed to determine a mercury species (such as analyzing the probe rinse and filter catch separately to determine total particulate mercury) and one fraction is not detected, it will be counted as zero. Total mercury for that species will be the sum of the detected values of the remaining fraction(s). For example, if the probe rinse had ND < 0.05 µg and the filter had 1.5 µg, total particulate mercury would be reported as 1.5 micrograms.

3.3.2 All fractions representing a mercury species are not detected.

If all fractions used to determine a mercury species are not detected, the total mercury for that species will be reported as not detected, at the sum of the detection limits of the individual species.

For example, if the probe rinse were not detected at 0.003 µg and the filter catch were not detected at 0.004 µg, the reported particulate mercury would be reported as ND <0.007 µg. This is expected to represent a small fraction (<1%) of the total mercury, even under worse case scenario of 1 µg/Nm^3.

3.3.3 No mercury is detected for a species on all three test runs.

When all three test runs show no detectable levels of mercury for a mercury species, that mercury species will be reported as not detected at less than the highest detection limit. For example, if three results for elemental mercury are ND < 0.10, ND <0.13, and ND < 0.10, the results would be reported as ND < 0.13 (the highest of the three detection levels).

In calculating total mercury, a value of zero will be used for that species. For example, if particulate mercury were ND < 0.11 µg, oxidized mercury were 2.0 µg, and elemental mercury were 3.0 µg, total mercury would be reported as 5.0 µg.

In calculating the percentage of mercury in the other two species, a value of zero will be used. For the example listed in the preceding paragraph, the results would be reported as 0% particulate mercury, 40% oxidized mercury, and 60% elemental mercury.

3.3.4 Mercury is detected on one or two of three runs.

If mercury is detected on one or two of three runs, average mercury will be calculated as the average of the detected value(s) and half of the detection limits for the non-detect(s).

Example 1: The results for three runs are 0.20, 0.20, and ND < 0.10. The reported value would be calculated as the average of 0.20, 0.20, and 0.05, which is 0.15 µg.
Example 2: The results for three runs are 0.14, ND < 0.1, and ND < 0.1. The average of 0.14, 0.05, and 0.05 is calculated to be 0.08 µg. Since this is below the detection limit of 0.1, the reported value is ND < 0.1.

3.4 Summary of Results

The results of the tests performed at Lawrence Unit Number 4 are listed in the following tables.

Table 3-2
Lawrence Unit Number 4 Source Emissions Results

Run Number	1	2	4
Test Date	10/25/99	10/26/99	10/26/99
Test Time	1735-1951	0900-1110	1740-2002
South Inlet Gas Properties			
Flow Rate – ACFM	192,780	190,001	195,545
Flow Rate – DSCFM*	110,885	112,488	112,416
% Water Vapor - % Vol.	8.82	9.43	9.19
CO_2 - %	12.6	13.0	12.8
O_2 - %	6.6	6.4	7.0
% Excess Air @ Sampling Point	45	43	49
Temperature - °F	341	315	337
Pressure – "Hg	28.53	28.60	28.49
Percent Isokinetic	101.0	99.8	98.6
Volume Dry Gas Sampled – DSCF*	47.558	47.682	47.072
South Stack Gas Properties			
Flow Rate – ACFM	169,862	169,712	176,787
Flow Rate – DSCFM*	118,159	121,818	125,352
% Water Vapor - % Vol.	16.94	15.09	15.23
CO_2 - %	12.4	12.2	12.3
O_2 - %	7.2	7.8	7.7
% Excess Air @ Sampling Point	51	58	57
Temperature - °F	155	151	155
Pressure – "Hg	29.08	29.16	29.04
Percent Isokinetic	96.8	95.3	97.1
Volume Dry Gas Sampled – DSCF*	65.662	66.640	69.913

* 29.92 "Hg, 68 °F (760 mm Hg; 20 °C)

Table 3-3
Lawrence Unit Number 4 Mercury Removal Efficiency

Run Number	1	2	4	Average
Test Date	10/25/99	10/26/99	10/26/99	
Test Time	1735-1951	0900-1110	1740-2002	
Total mercury				
Inlet - lb/10^{12} Btu	4.90	3.53	3.72	4.05
Stack - lb/10^{12} Btu	4.56	4.85	4.49	4.63
Removal efficiency - %	6.9	-----	-----	-----
Particulate mercury				
Inlet - lb/10^{12} Btu	0.16	0.38	0.17	0.24
Stack - lb/10^{12} Btu	0.01	0.06	0.07	0.05
Removal efficiency - %	93.8	84.2	58.8	-----
Oxidized mercury				
Inlet - lb/10^{12} Btu	1.18	<0.91	<1.03	<0.72
Stack - lb/10^{12} Btu	<0.070	<0.75	<0.073	<0.75
Removal efficiency - %	-----	-----	-----	-----
Elemental mercury				
Inlet - lb/10^{12} Btu	3.56	3.16	3.55	3.42
Stack - lb/10^{12} Btu	4.54	4.80	4.42	4.59
Removal efficiency, %	-----	-----	-----	-----

Table 3-4
Lawrence Unit Number 4 Mercury Speciation Results

Run Number	1	2	4	Average
Test Date	10/25/99	10/26/99	10/26/99	
Test Time	1735-1951	0900-1110	1740-2002	
South Inlet Mercury Speciation				
Particulate mercury – µg	0.242	0.580	0.250	—
µg/dscm	0.18	0.43	0.19	0.27
lbs/10^{12} Btu	0.16	0.38	0.17	0.24
% of total Hg	3.3	10.8	4.6	5.9
Oxidized mercury – µg	1.78	<1.40	<1.50	—
µg/dscm	1.32	<1.03	<1.13	<0.80
lbs/10^{12} Btu	1.18	<0.91	<1.03	<0.72
% of total Hg	24.1	0.0	0.0	—
Elemental mercury - µg	5.37	4.84	5.15	—
µg/dscm	3.99	3.58	3.86	3.81
lbs/10^{12} Btu	3.56	3.16	3.55	3.42
% of total Hg	72.7	89.5	95.4	85.9
Total mercury – µg	7.39	5.42	5.40	—
µg/dscm	5.49	4.01	4.05	4.52
lbs/10^{12} Btu	4.90	3.53	3.72	4.05
South Stack Mercury Speciation				
Particulate mercury – µg	0.026	0.111	0.138	—
µg/dscm	0.01	0.06	0.07	0.05
lbs/10^{12} Btu	0.01	0.06	0.07	0.05
% of total Hg	0.2	1.2	1.6	—
Oxidized mercury – µg	<1.40	<1.46	<1.50	<1.50
µg/dscm	<0.75	<0.77	<0.76	<0.77
lbs/10^{12} Btu	<0.70	<0.75	<0.73	<0.75
% of total Hg	0.0	0.0	0.0	—
Elemental mercury - µg	9.07	9.29	9.06	—
µg/dscm	4.88	4.92	4.58	4.79
lbs/10^{12} Btu	4.54	4.80	4.42	4.59
% of total Hg	99.6	99.0	98.4	99.0
Total mercury – µg	9.10	9.40	9.20	—
µg/dscm	4.89	4.98	4.65	4.84
lbs/10^{12} Btu	4.56	4.85	4.49	4.63
Coal Analysis				
Mercury - ppm dry	0.052	0.044	0.047	0.048
Mercury - lbs/10^{12} Btu	5.11	4.80	4.82	4.91
Chlorine - ppm dry	400	200	200	267
Moisture - %	16.9	18.3	17.5	17.6
Sulfur - % dry	0.58	0.45	0.44	0.49
Ash - % dry	8.62	7.03	6.68	7.44
HHV - Btu/lb as fired	10,200	10,020	10,180	10,133
Coal flow - lbs/hr as fired	96,000	104,000	101,800	100,600
Total Heat Input – 10^6 Btu/hr	979.2	1,042.1	1,036.3	1,019.2
Total Mercury Mass Rates				
lbs/hr input in coal	0.005	0.005	0.005	0.005
lbs/hr at FGD inlet	0.005	0.004	0.004	0.004
lbs/hr emitted	0.004	0.005	0.005	0.005

Table 3-5
Lawrence Unit Number 4 Process Data

Run Number	**1**	**2**	**3**
Test Date	10/25/99	10/26/99	10/26/99
Test Time	1735-1951	0900-1110	1740-2002
Unit Operation			
Unit Load - MW gross	100	100	100
Steam Flow – klbs/hr	782	792	795
Coal Mills in Service	All	All	All
Coal Flow - tons/hr	48.0	52.0	50.9
CEMS data			
CO_2 - % wet	11.3	10.8	11.1
SO_2 – ppm wet	19.1	15.6	15.4
NO_x – ppm wet	184.6	185.6	178.6
Stack Temperature - °F	157	149	158
Stack flow - kscfm	176.3	176.3	177.6
FGD data (401)			
Gas Outlet Temperature - °F	148	144	148
FGD data (402)			
Gas Outlet Temperature - °F	154	153	154

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Emission Test Methods

The sampling followed the procedures set forth in the Code of Federal Regulations, Title 40, Chapter I, Part 60, Appendix A, Methods 1, 2, 3B, 4, 5, 17, and 19; in the Ontario Hydro Method, Revised July 7, 1999 and ASTM Methods D2234, D6414-99, E776/300.0, D-4239, D-3174, and D-3286.

A preliminary velocity traverse was made at each of the five ports on the Unit Number 4 South Scrubber Inlet Duct, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 1.7 degrees. Alternate procedures would be required if the angle of cyclonic flow were greater than 20 degrees. Five traverse points were sampled from each of the five ports for a total of twenty-five traverse points at the inlet duct sampling location.

A preliminary velocity traverse was made at each of the two ports on the Unit Number 4 South Stack, in order to determine the uniformity and magnitude of the flow prior to testing. All traverse points were checked for cyclonic flow and the average angle was equal to 4.8 degrees. Alternate procedures would be required if the angle of cyclonic flow were greater than 20 degrees. Six traverse points were sampled from each of the two ports for a total of twelve traverse points at the stack sampling location.

The sampling trains were leak-checked at the end of the nozzle at 15 inches of mercury vacuum before each test, and again after each test at the highest vacuum reading recorded during each test. This was done to predetermine the possibility of a diluted sample.

The pitot tube lines were checked for leaks before and after each test under both a vacuum and a pressure. The lines were also checked for clearance and the manometer was zeroed before each test.

Integrated orsat samples were collected and analyzed according to EPA Method 3B during each test.

4.1.1 Mercury

Triplicate samples for mercury were collected. The samples were taken according to EPA Methods 1, 2, 3B, 4, 5 and 17; and the Ontario Hydro Method, Revised July 7, 1999. For each run at the inlet sampling location, samples of five-minute duration were taken isokinetically at each of the twenty-five traverse points for a total sampling time of 125 minutes. For each run at the stack sampling location, samples of ten-minute duration were taken isokinetically at each of the twelve sampling points for a total sampling time of 120 minutes. Data was recorded at five-minute intervals. Reagent blanks and field blanks were submitted.

The "front-half" of the sampling train at the inlet sampling location contained the following components:

Teflon Coated Nozzle
In-stack Quartz Fiber Thimble and Backup Filter and Teflon Coated Support
Heated Glass Probe @ > 248°F

The "front-half" of the sampling train at the stack sampling location contained the following components:

Teflon Coated Nozzle
Heated Glass Probe @ > 248°F
Heated Quartz Fiber Filter and Teflon Support @ > 248°F

The "back-half" of the sampling train at both sampling locations contained the following components:

Impinger Number	Impinger Type	Impinger Contents	Amount	Parameter Collected
1	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
2	Modified Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
3	Greenburg-Smith Design	1 mol/L KCL	100 ml	Oxidized Mercury and Moisture
4	Modified Design	5% HNO_3 and 10% H_2O_2	100 ml	Elemental Mercury and Moisture
5	Modified Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
6	Modified Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
7	Greenburg-Smith Design	4% $KMnO_4$ and 10% H_2SO_4	100 ml	Elemental Mercury and Moisture
8	Modified Design	Silica	200 g	Moisture

All glassware was cleaned prior to use according to the guidelines outlined in EPA Method 29, Section 5.1.1 and the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.15. All glassware connections were sealed with Teflon tape.

At the conclusion of each test, the filter and impinger contents were recovered according to procedures outlined in the Ontario Hydro Method, Revised July 7, 1999, Section 13.2.

Mercury samples were analyzed by Cold Vapor Atomic Absorption and Fluorescence Spectroscopy.

4.2 Process Test Methods

ASTM D2234 method of coal sampling was followed. For each test run, a grab sample of coal was collected from the outlet of each individual mill. One composite sample was prepared for analysis from the individual feeder samples. Each sample was analyzed for mercury, chlorine, sulfur, ash, and Btu content by ASTM Methods D6414-99, E766/300.0, D-4239, D-3174, and D-3286, respectively.

4.3 Sample Tracking and Custody

Samples and reagents were maintained in limited access, locked storage at all times prior to the test dates. While on site, they were at an attended location or in an area with limited access. Off site, METCO and TestAmerica provided limited access, locked storage areas for maintaining custody.

Chain of custody forms are located in Appendix F. The chain of custody forms will provide a detailed record of custody during sampling, with the initials noted of the individuals who load and recover impingers and filters and perform probe rinses.

All samples were packed and shipped in accordance with regulations for hazardous substances.

5 QA/QC ACTIVITIES

The major project quality control checks are listed in Table 5-1. Matrix Spike Summaries are listed in Table 5-2. Duplicate and Triplicate Analyses Summaries are listed in Table 5-3. Additional method-specific QC checks are presented in Table 5-4 (Methods 1 and 2), Table 5-5 (Method 5/17 sampling), and Table 5-6 (Ontario Hydro sample recovery and analysis). These tables also include calibration frequency and specifications.

Table 5-1
Major Project Quality Control Checks

QC Check	*Information Provided*	*Results*
Blanks		
Reagent blank	Bias from contaminated reagent	No Mercury was detected
Field blank	Bias from handling and glassware	No Mercury was detected
Spikes		
Matrix spike	Analytical bias	Sample results were between 75% - 125% recovery
Replicates		
Duplicate analyses	Analytical precision	Results were < 10% RPD
Triplicate analyses	Analytical precision	Results were < 10% RPD

Table 5-2
Matrix Spike Summary

Sampling Location	*Run Number*	*Container*	*Results (ug)*	*True Value (ug)*	*Recovery (%)*
Inlet Duct	1	1B	0.0555	0.050	111
Inlet Duct	1	4	3.86	3.58	108
Inlet Duct	1	5	4.89	4.75	106
Inlet Duct	2	3	7.76	6.99	111
Inlet Duct	4	1A	0.059	0.050	118
Stack	1	2	1.295	1.33	97

Table 5-3
Duplicate and Triplicate Analyses Summary

Sampling Location	*Run Number*	*Container*	*Results (ug)*	*Duplicate Results (ug)*	*RPD*	*Triplicate Results (ug)*	*RPD*
Scrubber 1B Inlet Duct	1	1A	0.242	0.241	0.5	0.240	1.2
		1B	<0.01	<0.01	0	—	—
		2	<0.15	<0.15	0	—	—
		3	1.78	1.71	3.9	—	—
		4	<0.72	<0.72	0	—	—
		5	5.37	5.46	1.8	—	—
	2	1A	0.580	0.585	0.8	—	—
		1B	<0.01	<0.01	0	—	—
		2	<0.19	<0.19	0	—	—
		3	<1.40	<1.40	0	—	—
		4	<0.72	<0.72	0	—	—
		5	4.84	4.85	0.2	—	—
	3	1A	0.250	0.250	0	0.252	0.6
		1B	<0.01	<0.01	0	—	—
		2	<0.22	<0.22	0	—	—
		3	<1.50	<1.50	0	—	—
		4	<0.74	<0.74	0	—	—
		5	5.15	5.20	1.0	—	—
1A Stack	1	1A	0.026	0.025	2.8	—	—
		2	<0.27	<0.27	0	—	—
		3	<1.40	<1.40	0	<1.40	0
		4	<0.70	<0.70	0	—	—
		5	9.07	9.12	0.5	—	—
	2	1A	0.111	0.109	1.8	—	—
		2	<0.43	<0.43	0	—	—
		3	<1.46	<1.46	0	—	—
		4	<0.66	<0.66	0	—	—
		5	9.29	9.34	0.5	—	—
	3	1A	0.138	0.137	1.1	—	—
		2	<0.37	<0.37	0	—	—
		3	<1.50	<1.50	0	—	—
		4	<0.72	<0.72	0	—	—
		5	9.06	8.91	1.6	—	—

Table 5-4
QC Checklist and Limits for Methods 1 and 2

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Measurement site evaluation	>2 diameters downstream and 0.5 diameters upstream of disturbances	Method 1, Section 2.1
Pitot tube inspection	Inspect each use for damage, once per program for design tolerances	Method 2, Figures 2-2 and 2-3
Thermocouple	+/- 1.5% (°R) of ASTM thermometer, before and after each test mobilization	Method 2, Section 4.3
Barometer	Calibrate each program vs. mercury barometer or vs. weather station with altitude correction	Method 2, Section 4.4

Table 5-5
QC Checklist and Limits for Method 5/17 Sampling

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Pre-mobilization checks		
Gas meter/orifice check	Before test series, Y_D +/- 5% (of original Y_D)	Method 5, Section 5.3
Probe heating system	Continuity and resistance check on element	
Nozzles	Note number, size, material	
Glassware	Inspect for cleanliness, compatibility	
Thermocouples	Same as Method 2	
On-site pre-test checks		
Nozzle	Measure inner diameter before first run	Method 5, Section 5.1
Probe heater	Confirm ability to reach temperature	
Pitot tube leak check	No leakage	Method 2, Section 3.1
Visible inspection of train	Confirm cleanliness, proper assembly	
Sample train leak check	$\leq$0.02 cf at 15" Hg vacuum	Method 5, Section 4.1.4
During testing		
Probe and filter temperature	Monitor and confirm proper operation	
Manometer	Check level and zero periodically	
Nozzle	Inspect for damage or contamination after each traverse	Method 5, Section 5.1
Probe/nozzle orientation	Confirm at each point	
Post test checks		
Sample train leak check	$\leq$0.02 cf at highest vacuum achieved during test	Method 5, Section 4.1.4
Pitot tube leak check	No leakage	Method 2, Section 3.1
Isokinetic ratio	Calculate, must be 90-110%	Method 5, Section 6
Dry gas meter calibration check	After test series, Y_D +/- 5%	Method 5, Section 5.3
Thermocouples	Same as Method 2	
Barometer	Compare w/ standard, +/- 0.1" Hg	

Table 5-6 QC Checklist and Limits for Ontario Hydro Mercury Speciation

Quality Control Activity	Acceptance Criteria and Frequency	Reference
Pre-mobilization activities		
Reagent grade	ACS reagent grade	Ontario Hydro Section 8.1
Water purity	ASTM Type II, Specification D 1193	Ontario Hydro Section 8.2
Sample filters	Quartz; analyze blank for Hg before test	Ontario Hydro Section 8.4.3
Glassware cleaning	As described in Method	Ontario Hydro Section 8.10
On-site pre-test activities		
Determine SO_2 concentration	If >2500 ppm, add more HNO_3-H_2O_2 solution	Ontario Hydro Section 13.1.13
Prepare KCl solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare HNO_3-H_2O_2 solution	Prepare batch as needed	Ontario Hydro Section 8.5
Prepare H_2SO_4-$KMnO_4$ solution	Prepare daily	Ontario Hydro Section 8.5
Prepare HNO_3 rinse solution	Prepare batch as needed; can be purchased premixed	Ontario Hydro Section 8.6
Prepare hydroxylamine solution	Prepare batch as needed	Ontario Hydro Section 8.6
Sample recovery activities		
Brushes and recovery materials	No metallic material allowed	Ontario Hydro Section 13.2.6
Check for $KMnO_4$ Depletion	If purple color lost in first two impingers, repeat test with more HNO_3-H_2O_2 solution	Ontario Hydro Section 13.1.13
Probe cleaning	Move probe to clean area before cleaning	Ontario Hydro Section 13.2.1
Impinger 1,2,3 recovery.	After rinsing, add permanganate until purple color remains to assure Hg retention	Ontario Hydro Section 13.2.8
Impinger 5,6,7 recovery.	If deposits remain after HNO_3 rinse, rinse with hydroxylamine sulfate. If purple color disappears after hydroxylamine sulfate rinse, add more permangante until color returns	Ontario Hydro Section 13.2.10
Impinger 8	Note color of silica gel; if spent, regenerate or dispose.	Ontario Hydro Section 13.2.11
Blank samples		
0.1 N HNO_3 rinse solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
KCl solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
HNO_3-H_2O_2 solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
H_2SO_4-$KMnO_4$ solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Hydroxylamine sulfate solution	One reagent blank per batch.	Ontario Hydro Section 13.2.12
Unused filters	Three from same lot.	Ontario Hydro Section 13.2.12
Field blanks	One per set of tests at each test location.	Ontario Hydro Section 13.4.1
Laboratory activities		
Assess reagent blank levels	Target <10% of sample value or <10x instrument detection limit. Subtract as allowed.	Ontario Hydro Section 13.4.1
Assess field blank levels	Compare to sample results. If greater than reagent blanks or greater than 30% of sample values, investigate. Subtraction of field blanks not allowed.	Ontario Hydro Section 13.4.1
Duplicate/triplicate samples	All CVAAS runs in duplicate; every tenth run in triplicate. All samples must be within 10% of each other; if not, recalibrate and reanalyze.	Ontario Hydro Section 13.4.1

6 DESCRIPTION OF TESTS

Personnel from METCO Environmental arrived at the plant at 10:30 a.m. on Monday, October 25, 1999. After meeting with plant personnel and attending a brief safety meeting, the equipment was moved onto the Unit Number 4 South Scrubber Inlet Duct and South Stack. The preliminary data was collected. The first set of tests for mercury began at 5:35 p.m. and was completed at 7:51 p.m. The samples were recovered. The equipment was secured for the night. All work was completed at 9:45 p.m.

On Tuesday, October 26, work began at 6:30 a.m. The equipment was prepared for testing. The second set of tests for mercury began at 9:00 a.m. Testing continued until the completion of the fourth set of tests at 8:02 p.m. The third set of tests was aborted due to sampling equipment problems.

The samples were recovered. The equipment was moved off of the sampling locations and loaded into the sampling van. The samples and the data were transported to METCO Environmental's laboratory in Dallas, Texas, for analysis and evaluation.

Operation at Western Resources, Inc., Lawrence Energy Center, Unit Number 4 South Scrubber Inlet Duct and Unit Number 4 South Stack, located in Lawrence, Kansas, for the Electric Power Research Institute, were completed at 10:30 p.m. on Tuesday, October 26, 1999.

Billy J. Mullins, Jr.

Billy J. Mullins, Jr. P.E.
President

7 APPENDICES

A. Source Emissions Calculations

B. Field Data

C. Calibration Data

D. Analytical Data

E. Unit Operational Data

F. Chain of Custody Records

G. Resumes